**Course:** Math 8 **CCSS Standard Number(s):**  8.EE.1 and 8.F.5 **Day:** 7

**Unit # and Title:** Unit 1: Introducing Exponential Relationships **Block(s)/Period(s):** 1 2 3 4 5 6

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| **Unit Essential Question(s):** | When would use the properties of integer exponents? | | |
| **Learning Target(s)**  **“I can statements”** | I can recognize and apply the properties of integer exponents. (positive and negative)  I can generate equivalent numerical expressions using the properties of integer exponents. | | |
| **Essential Vocabulary** | exponent  expression  laws of exponents  standard form | | |
| **Resources and Materials** | **Teacher** | | **Student** |
| * Connected Mathematics 2 Growing, Growing, Growing: Exponential Relationships-teacher edition (if available) * Blank paper (1 sheet per pair or group) * Scissors | | * [Connected Mathematics 2 Growing, Growing, Growing: Exponential Relationships-student edition](http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&ved=0CE8QFjAD&url=http%3A%2F%2Fteacherweb.com%2FCO%2FHenryWorldSchool%2FMortimer%2FStudentBook_GrowingGrowingGrowing.pdf&ei=TFcRUJq5IYe29QS79oDICg&usg=AFQjCNGH8Iel0_Z_hgF97kPg6QN7RqpIQQ&sig2=04) Calculator * Student notebook for recording their findings |
| **8 Mathematical Practices:** | | | |
| **1. Make sense of problems and persevere in solving them.**  2. Reason abstractly and quantitatively.  **3. Construct viable arguments and critique the reasoning of others.**  4. Model with mathematics. | | **5. Use appropriate tools strategically.**  **6. Attend to precision.**  **7. Look for and make use of structure.**  8. Look for and express regularity in repeated reasoning. | |
| **Activating Strategy**  **(Opening Activity)** | Teacher will describe Chen’s ballot-making task (pg. 5):   |  |  | | --- | --- | | Number of Cuts | Number of Ballots | | 1 | 2 | | 2 | 4 | | 3 |  | | 4 |  |   You might ask students to jot down predictions for the number of ballots that would result from three, four, or even ten cuts. Later, they can compare their predictions to the results they obtain in the activity. | | |
| **Cognitive Teaching Strategies**  **Me/We/Few/You**  **(TIP-Teacher input**  **SAP-Student actively participates**  **GP – Guided Practice**  **IP-Independent Practice)** | Have students cut and stack paper for the first two or three cuts. This provides a visual aid to help them understand the relationship between the number of cuts and the number of ballots created. (**SAP**)  Students will complete Problem 1.1 (pg. 6) in a group (2 to 4 students). It is important that students at least complete problems A – C. Problem D can be use as an extension.  Encourage students to look for the multiplicative pattern in the table.   * *How did you find each of the entries in your table:* * *What is the relationship between this number of ballots and the previous number of ballots?* * *Explain the relationship in terms of the number of cuts.*   As students work on Questions C and D, look for interesting strategies to share in the summary. (**TIP**) | | |
| **Summarizing Strategy**  **(Closing Activity)** | As groups share their answers to the problem, ask questions such as:   * *How do your results compare to the predictions you made earlier?* * *How is the number of ballots obtained with each cut related to the number of ballots before the cut?* * *Question C asked how many ballots are made after 20 cuts and after 30 cuts. Describe how you found your answers.* * *Question D asked you to work in reverse to predict the number of cuts needed to make enough ballots for 500 students. Describe your method.*   By asking about patterns in the table relating the number of cuts to the number of ballots, lead the class to a discussion of exponents.  Display the table from Problem 1.1 on the overhead and ask:   * *How did you get the number of ballots for 5 cuts?*   Add a third column to the table and illustrate each calculation, showing each factor of 2.  Use the example below to introduce the terms base, exponent, exponential form, and standard form.  2 x 2 x 2 x 2 x 2 x 2 x 2 x 2 x 2 x 2 = 210  Explain that 1,024 is the standard form of 210   * *How many ballots are there after 0 cuts?* * *How could we show this in our table?* | | |
| **Assessment/Homework** | Homework: Student Edition ACE Problems (pg. 11): 1 - 4 | | |
| **Extending/Refining** | The extending and refining are built into the teaching strategies and closing activity through questioning.  Possible questions to ask students who are struggling:   * Every time you make a cut, what is happening to number of ballots? * What are some strategies to determine the number of ballots after a specified number of cuts?   Possible questions to ask students who need an extension:   * Is there a rule to represent the relationship between the number of cuts and the number of ballots? | | |

**Course:** Math 8 **CCSS Standard Number(s):**  8.EE.1 and 8.F.5 **Day:** 8

**Unit # and Title:** Unit 1: Introducing Exponential Relationships **Block(s)/Period(s):** 1 2 3 4 5 6

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| **Unit Essential Question(s):** | When would use the properties of integer exponents? | | |
| **Learning Target(s)**  **“I can statements”** | I can recognize and apply the properties of integer exponents. (positive and negative)  I can generate equivalent numerical expressions using the properties of integer exponents. | | |
| **Essential Vocabulary** | exponent  expression  laws of exponents  standard form | | |
| **Resources and Materials** | **Teacher** | | **Student** |
| * Connected Mathematics 2 Growing, Growing, Growing: Exponential Relationships-teacher edition (if available) * A copy of blank chessboard for each group is optional * Counters to serves as rubas (optional; about 65 per group) | | * [Connected Mathematics 2 Growing, Growing, Growing: Exponential Relationships-student edition](http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&ved=0CE8QFjAD&url=http%3A%2F%2Fteacherweb.com%2FCO%2FHenryWorldSchool%2FMortimer%2FStudentBook_GrowingGrowingGrowing.pdf&ei=TFcRUJq5IYe29QS79oDICg&usg=AFQjCNGH8Iel0_Z_hgF97kPg6QN7RqpIQQ&sig2=04) * Calculator * Student notebook for recording their findings * Graph paper |
| **8 Mathematical Practices:** | | | |
| **1. Make sense of problems and persevere in solving them.**  2. Reason abstractly and quantitatively.  **3. Construct viable arguments and critique the reasoning of others.**  4. Model with mathematics. | | **5. Use appropriate tools strategically.**  **6. Attend to precision.**  **7. Look for and make use of structure.**  8. Look for and express regularity in repeated reasoning. | |
| **Activating Strategy**  **(Opening Activity)** | Teacher will introduce key vocabulary and allow students to practice writing expressions in exponential and standard form with and without the use of a calculator.  Allow student 3 to 5 minutes to complete the Getting Ready for Problem 1.2 on pg. 6. After a discussion of the Getting Ready for Problem 1.2 (students can complete this individually). Tell the story of the peasant and the king of Montarek (pg. 7).  Possible questions to pose:   * *How many rubas will there be on square 1? On square 2? On square 3? On square 4?* * *Which square will have 64 rubas?*   Pose the following questions, and record all students responses. Later students can compare their predictions to the their findings.   * *How many rubas do you think will be placed on the last square of the chessboard?* * *If a Montarek ruba is worth 1 cent, do you think the peasant’s plan is good deal for her?* | | |
| **Cognitive Teaching Strategies**  **Me/We/Few/You**  **(TIP-Teacher input**  **SAP-Student actively participates**  **GP – Guided Practice**  **IP-Independent Practice)** | Have students work in groups (2 to 4 students) on Problem 1.2 (A – D are essential; E and F can be used as extensions). If students are struggling to write the equation, then have a two groups share their graphs with the class and ask the following questions about the relationship to aid in helping students to come up with the equation:   * *How many rubas are on square 4? How can you write this as a power of 2?* * *How many rubas are on square 5? How can you write this as a power of 2?* * *How many rubas are on square 6? How can you write this as a power of 2?* * *How can you write the number of rubas on the nth square as a power of 2? So, what is the equation? (****GP/SAP****)* | | |
| **Summarizing Strategy**  **(Closing Activity)** | As a class, discuss the graph and how it represents the growth pattern. Have students share the methods they used for finding the equation.  Discuss the questions you posed in the Opening Activity and compare the answers to the students’ predictions.   * *How many rubas will be on the last square? How did you find that number?* * *If each ruba is worth 1 cent, what is the value of the rubas on the last square in dollars? How did you find this answer?* * *Is this plan a good deal for the peasant?*   Ask students to compare the ballot-cutting and chessboard situations.   * *In what ways are the chessboard and ballot-cutting situations similar? In what ways are they different?*   Summary:   1. Describe features of an exponential growth pattern. 2. Create a table and graph for the following function: y = 2x | | |
| **Assessment/Homework** | Homework: Student Edition ACE Problems (pg. 12): 21 | | |
| **Extending/Refining** | The extending and refining are built into the teaching strategies and closing activity through questioning. Ideas for extending and refining were included above. | | |

**Course:** Math 8 **CCSS Standard Number(s):**  8.EE.1 and 8.F.5 **Day:** 9

**Unit # and Title:** Unit 1: Predicting the Ones Digit **Block(s)/Period(s):** 1 2 3 4 5 6

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| **Unit Essential Question(s):** | When would use the properties of integer exponents? | | |
| **Learning Target(s)**  **“I can statements”** | I can recognize and apply the properties of integer exponents. (positive and negative)  I can generate equivalent numerical expressions using the properties of integer exponents. | | |
| **Essential Vocabulary** | exponent  expression  laws of exponents  standard form | | |
| **Resources and Materials** | **Teacher** | | **Student** |
| * Connected Mathematics 2 Growing, Growing, Growing: Exponential Relationships-teacher edition (if available) * A copy of the table on pg. 60 can be typed up and given to students to save time (optional) | | * [Connected Mathematics 2 Growing, Growing, Growing: Exponential Relationships-student edition](http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&ved=0CE8QFjAD&url=http%3A%2F%2Fteacherweb.com%2FCO%2FHenryWorldSchool%2FMortimer%2FStudentBook_GrowingGrowingGrowing.pdf&ei=TFcRUJq5IYe29QS79oDICg&usg=AFQjCNGH8Iel0_Z_hgF97kPg6QN7RqpIQQ&sig2=04) * Calculator * Student notebook for recording their findings |
| **8 Mathematical Practices:** | | | |
| **1. Make sense of problems and persevere in solving them.**  2. Reason abstractly and quantitatively.  **3. Construct viable arguments and critique the reasoning of others.**  4. Model with mathematics. | | **5. Use appropriate tools strategically.**  **6. Attend to precision.**  **7. Look for and make use of structure.**  8. Look for and express regularity in repeated reasoning. | |
| **Activating Strategy**  **(Opening Activity)** | Open this activity by writing the values of y = 2x, for x = 1 to 8. Write both the exponential and standard form for 2x in the y-column.  Let students look for patterns. Use the Getting Ready to focus student on the patterns.   * *Look at the column of y-values in the table. What pattern do you see in how the ones digits of the standard form change?* * *Can you predict the ones digits for 215? What about 250?* * *What other patterns do you see in the table?* | | |
| **Cognitive Teaching Strategies**  **Me/We/Few/You**  **(TIP-Teacher input**  **SAP-Student actively participates**  **GP – Guided Practice**  **IP-Independent Practice)** | Students should complete Problem 5.1 (pg. 60 - 61) A on their own and then work in groups (2 to four students) for B – F. (**IP and GP**)  If students are having trouble using the patterns of the ones digits, ask:   * *What are the lengths of the cycles of repeating ones digits?* * *Which bases have a cycle of length 4?* * *Which bases have a cycle of length 1?* * *Which bases have a cycle of length 2?* * *If you know the exponent, how can you sue the pattern of the cycle to determine the ones digit of the power?* * *If you were to look at the ones digits for powers of 12, you would find that they follow the same pattern as the ones digits for the powers of 2. Why do you think this is true?* * *What affects the ones digit?* (**GP)**   In Question E, remind students to use their knowledge about the patterns of the ones digit to narrow the choices down. Make not of interesting patterns, reasoning, and questions that arise. (**TIP**) | | |
| **Summarizing Strategy**  **(Closing Activity)** | Display a completed powers table on the board for students to refer to, both during the this summary and for the next problem.  Ask for general patterns. Ask students to give reasons for the patterns.  Go over some of the powers in Questions C and D. Be sure to have students explain their strategies. | | |
| **Assessment/Homework** | Homework: Student Edition ACE Problems (pg. 64): 1 - 7 | | |
| **Extending/Refining** | The extending and refining are built into the teaching strategies and closing activity through questioning. Ideas for extending and refining were included above. | | |

**Course:** Math 8 **CCSS Standard Number(s):**  8.EE.1 and 8.F.5 **Day:** 10 and 11

**Unit # and Title:** Unit 1: Introducing Exponential Relationships **Block(s)/Period(s):** 1 2 3 4 5 6

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| **Unit Essential Question(s):** | When would use the properties of integer exponents? | | |
| **Learning Target(s)**  **“I can statements”** | I can recognize and apply the properties of integer exponents. (positive and negative)  I can generate equivalent numerical expressions using the properties of integer exponents. | | |
| **Essential Vocabulary** | exponent  expression  laws of exponents  standard form | | |
| **Resources and Materials** | **Teacher** | | **Student** |
| * Connected Mathematics 2 Growing, Growing, Growing: Exponential Relationships-teacher edition (if available) | | * [Connected Mathematics 2 Growing, Growing, Growing: Exponential Relationships-student edition](http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&ved=0CE8QFjAD&url=http%3A%2F%2Fteacherweb.com%2FCO%2FHenryWorldSchool%2FMortimer%2FStudentBook_GrowingGrowingGrowing.pdf&ei=TFcRUJq5IYe29QS79oDICg&usg=AFQjCNGH8Iel0_Z_hgF97kPg6QN7RqpIQQ&sig2=04) Calculator * Student notebook for recording their findings * A completed copy of the table from the previous investigation |
| **8 Mathematical Practices:** | | | |
| **1. Make sense of problems and persevere in solving them.**  2. Reason abstractly and quantitatively.  **3. Construct viable arguments and critique the reasoning of others.**  4. Model with mathematics. | | **5. Use appropriate tools strategically.**  **6. Attend to precision.**  **7. Look for and make use of structure.**  8. Look for and express regularity in repeated reasoning. | |
| **Activating Strategy**  **(Opening Activity)** | Refer to the completed powers table from the previous investigation. Use the Getting Ready (pg. 61) to encourage students to begin noticing patterns that will lead to the rules of exponents.  Tell students that in this problem, they will look for a way to generalize patterns for exponents. | | |
| **Cognitive Teaching Strategies**  **Me/We/Few/You**  **(TIP-Teacher input**  **SAP-Student actively participates**  **GP – Guided Practice**  **IP-Independent Practice)** | Students should complete Problem 5.2 (pg. 62) A – E in groups (2 to four students) for B – F. (**IP and GP**)  The questions are structured so that most students should be able to see the patterns. Students look at specific cases of each pattern first and are then asked to generalize the patterns. (**TIP**)  The key to understanding why the rules of exponents work is for students to visualize the structure of *am* as the product of *a* used *m* times. **This part of the investigation may take the entire class period; therefore, the summary should take place the following day, along with practice.** | | |
| **Summarizing Strategy**  **(Closing Activity)** | Ask different groups to present their reasoning for each part of the problem. Use the completed powers table to illustrate the rules. For example, the rule am x an = am+n can be illustrated by looking at any column. | | |
| **Assessment/Homework** | Practice Problems (not included)  Homework should be given on day 11. Student Edition ACE Problems (pg. 65): 31a-c | | |
| **Extending/Refining** | The extending and refining are built into the teaching strategies and closing activity through questioning. Ideas for extending and refining were included above. | | |